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APPLICATION FOR LETTERS PATENT

FOR

A FUEL INJECTION VALVE

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A FUEL INJECTION VALVE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of co-pending International Application No. PCT/DE02/03628 filed September 25, 2002 which designates the United States,
5 and claims priority to German application number DE10147792.9 filed September 27, 2001.

TECHNICAL FIELD OF THE INVENTION

The invention relates to a valve, in particular a fuel injection valve for a high-pressure accumulator
10 injection system of an internal combustion engine.

BACKGROUND OF THE INVENTION

With conventional fuel injectors for injection systems of internal combustion engines the fuel injection
15 nozzle is typically controlled by means of a valve needle, which is arranged to form a moving seal within a guide in a valve body of an injection valve. The valve needle features a valve needle seat at its tip, which, together with a valve body seat of the valve body, opens
20 or closes at least one spray orifice to the combustion chamber of the internal combustion engine. The at least one spray orifice is typically located in the area of the valve body seat.

With the pressures which arise, the sealing edges
25 and passages in the fuel injector are subject to significant mechanical stress, which also varies greatly during operation. The sealing of the injection valve is therefore especially important, even with common-rail systems, since by contrast with conventional systems for

periodic injection, these are permanently under system pressure in each case so that bad seals can lead to continuous injection.

A seal between the pressure chamber and the leakage
5 chamber can only be made between spray valve body and axially moving spray valve needle by means of a sealing gap, since any type of conventional elastic seal would not be able to withstand the high pressure loads over the long term. The sealing gap must be manufactured very
10 precisely in order to be able, even with variations in temperature and the resulting material expansions, to simultaneously guarantee smooth guidance of the valve needle and thereby the best possible sealing effect.

An additional problem is caused by the fact that,
15 with a common-rail injector there is a valve control piston to control the valve needle present in addition to the valve needle of the injection valve, which is also sealed by a gap seal against the exhaust chamber. The result of constantly high pressure on a number of gap
20 seals is a relative large volume of leakage which adversely affects the overall efficiency of the system. One way of avoiding this leakage is to reduce the guide play to a low figure of 1,5 to 2,5 μm between valve needle seat and valve body. A further measure consists of
25 coating the needle in the area of its guide, in a form of plastic coatings for example. As large a guide length as possible ($> 10 \text{ mm}$) of the valve needle can also reduce leakage. The play in the guide is however limited by
30 lubrication and the guide length by the maximum dimensions of the injector.

SUMMARY OF THE INVENTION

One aim of the invention is to minimize the leakage of a fuel injection valve of a high-pressure accumulator injection system.

5 This aim of the invention is achieved with a fuel injection valve in accordance with the high-pressure accumulator injection system of an internal combustion engine, which features a valve body with a valve body seat and a valve needle with a valve needle seat guided
10 over a guide length in the valve body within a stationary circular guiding surface for controlling a spray orifice, characterized in that in the valve body a pressure reservoir under high pressure in the shape of an annular groove, arranged coaxially to the guiding surface is
15 provided.

With a valve, especially a fuel injection valve for a high-pressure accumulator injection system of an internal combustion engine, a valve body with a valve body seat as well as a valve needle guided within the
20 valve body in a stationary circular cylinder guide surface over the guide length with a valve needle seat for controlling a spray orifice is provided. In accordance with the invention there is further provision for the presence of a pressure reservoir operating under
25 high pressure in the shape of an annular groove arranged coaxially in relation to the guiding surface.

This inventive valve has the advantage of reduced leakage between the guiding surface in the valve body and a valve needle guide since the pressure reservoir under
30 high pressure in the form of an annular groove causes an elastic deformation of the guiding surface of the valve

body towards the valve needle guide. The elastic deformation reduces the seal gap between the valve needle guide and the guiding surface to a minimum and thus ensures greatly reduced leakage.

5 A preferred embodiment of the invention provides for the annular groove to be separated by a hollow-cylinder-shaped cutout in the wall of the guiding surface of the valve body. When the high pressures occur in the annular groove this wall section is subject to elastic
10 deformation in the direction of the valve needle guide and thus ensures a reduction in fuel leakage.

 Preferably the depth of the annular groove is least one 5th of the guide length of the valve needle guide, giving the benefit of a sufficiently long wall section
15 that can be elastically deformed in the desired manner. The annular groove can however essentially be embodied deeper, for example up to half the guide length of the valve needle guide.

 A preferred embodiment of the invention provides a
20 hydraulic connection between the fuel inlet of a pressure chamber in the valve body and the annular groove, with the annular groove being under the full high pressure in the injection valve at all times. In this way the deformation of the wall section is simultaneously
25 dependent on the fuel pressure present in the annular groove. This has the advantage that leakage which normally becomes greater at high pressure can be reduced by the sealing gap which simultaneously becomes less at high pressure.

The annular groove preferably has a thickness which is at least one fifth of the diameter of the guiding surface. Preferably the wall section between valve body and annular groove has a thickness which roughly
5 corresponds to the thickness of the annular groove.

In summary the aspects of the invention are as follows. The leakage gap in the needle guide is separated from the annular groove by the wall section. The annular groove is connected by a connecting groove in the valve
10 body to the high pressure bore. When pressure builds up in the injection system the same hydraulic pressure thus occurs in the annular groove as occurs in the pressure chamber of the injector. On the wall of the needle side (inner wall) there is only the leakage pressure which is
15 smaller by an order of magnitude than the pressure in the high-pressure chamber and the annular groove. The pressure difference produced deforms the wall section and the gap in the needle guide is reduced to a minimum. Since the leakage through the needle guide is
20 proportional to the width of the gap it is consequently reduced in the desired way.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is now explained in greater detail
25 using exemplary embodiments which refer to the enclosed Figures. The diagrams show:

Figure 1 a schematic cross sectional view of the fuel injection valve in accordance with the invention;
and

30 Figure 2 a view from above of the fuel injection valve in accordance with Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

Figure 1 shows a fuel injection valve in accordance with the invention in a schematic cross sectional view.

5 The fuel injection valve 2 consists of a valve body 4 and a valve needle 6 which is guided sealed with a valve needle guide 8 within the valve body 4.

One or more spray orifices 16 are provided in a pocket hole 12 of the valve body 4. The valve needle 6
10 features a tip 7 with a seating edge 14 and a valve needle seat 18. This valve needle seat 18 sits on a valve body seat 20 thus seals the injection valve 2 with the spray orifices 16.

Via the fuel inlet 26 and a circular pressure
15 chamber 22 lying between the valve needle 6 and the valve body 4 the fuel reaches the seat edge 14 and with valve needle 6 lifted, passes along the circular chamber 28 between valve needle 6 and valve body on via the pocket hole 12 and the spray orifice 16 into the combustion
20 chamber of the internal combustion engine.

Between a cylinder-shaped valve needle guide 8 in the upper area of the valve needle 6, of which the diameter is enlarged in relation to the needle shaft and a guiding surface 10 in valve body 4 which features a
25 cylindrical internal surface, there is a sealing gap 11. Through this sealing gap 11 the high pressure 22 obtaining in the pressure chamber is continually reduced in relation to a leakage area 36 above the valve needle 6.

30 Coaxially to the guiding surface 10 in valve body 4 there is provision for an annular groove 32 which has a

rectangular cross section with a depth T. The depth T of the annular groove 32 amounts in the exemplary embodiment shown to approximately half a guide length L, which characterizes the length of the axial guide of the valve
5 needle 6 with its valve needle guide 8 within the hollow-cylinder-shaped guiding surface. The guiding length L can typically be around 10 mm so that the depth T typically has a value of around 5 mm.

The depth T however amounts to at least one fifth of
10 the guiding length of the valve needle guide 8, so that in this case the depth T has a value of around 2 mm.

The annular groove 32 is connected via a connecting groove 34 to the fuel inlet 26, so that the full fuel pressure is always present in the annular groove 32. In
15 the upper area of the valve needle guide 8 or the sealing gap 11 the full fuel pressure is no longer present so that the hollow cylindrical wall section 30 between annular groove 32 and guiding surface 10 is elastically deformed inwards in the direction of the valve guide 8.
20 In this way the sealing gap 11 is made smaller close to the leakage area 36, which reduces the fuel leakage through the sealing gap 11 overall.

Figure 2 shows an overhead view of the fuel injection valve in accordance with Figure 1. This diagram
25 again clearly shows the circular-shaped contour of the annular groove 32. The thickness D_N of the annular groove 32 can approximately correspond to the thickness D_W of the wall section 30. Also visible in this drawing is the connecting groove 34 which provides a hydraulic
30 connection between the fuel inlet 26 and the annular groove 32.

For a typical diameter of the valve needle guide 8 of 3.0 to 4.0 mm the thickness D_w of the wall section 30 as well as the thickness D_N , of the annular groove 32 can be a value of around 1 mm in each case.